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Relationships Between Weighting Factors and Normalisation in Life Cycle Impact Assessment

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In Life Cycle Assessment, practitioners sometimes wish to use weighting factors of impact categories in order to obtain a single comparison metric for results of Life Cycle Impact Assessment (LCIA). Many methods, such as economic, panel and distance-to-target approaches, can be used to obtain weighting factors. Different methods produce different weighting factors depending on several factors. One important issue is how the weighting factors are understood. For example, in the panel method we can use an elicitation technique called ratio estimation (see von Winterfeldt and Edwards 1986) with the question form "How much do you prefer to restrict emissions causing acidification as compared to those causing aquatic eutrophication (or vice versa)?" However, the question form does not constitute an acceptable standpoint for a procedure of preference elicitation if emissions are not specified. Are we talking about emissions from Finland or from the whole of Europe?

Assume that we have weighting factors obtained from the weighting task in which different impact category effects caused by Finnish emissions were compared to each other. According to multiattribute value theory (MAVT) the use of these weighting factors in the aggregation rule commonly used in LCIA requires normalisation, in which reference values are calculated on the basis of the Finnish emissions (Seppälä 1997, 1999). Thus,

$$I(a) = \sum_{i=1}^n w_i^F \cdot \frac{I_i(a)}{N_i(F)} \quad (1)$$

where $I(a)$ is a total environmental impact caused by product system a , w_i^F is a weighting factor (or weight) of impact category i ($i = 1, \dots, n$) related to adverse effects caused by emissions from Finland, $I_i(a)$ is an indicator result of impact category i caused by product system a and $N_i(F)$ is a reference value (or normalisation factor) of impact category i caused by emissions from Finland.

If impact category effects caused by European emissions are weighted against each other in the weighting task, we get weighting factors w_i^E related to European emissions instead of w_i^F . According to MAVT the use of these weighting factors in the aggregation needs reference values $N_i(E)$ calculated by emissions from Europe.

Equation 1 offers an explanation for the calculation rule of total environmental impact $I(a)$ which does not seem to include normalisation, i.e.

$$I(a) = \sum_{i=1}^n w_i \cdot I_i(a) \quad (2)$$

This calculation rule is consistent with MAVT if the weighting factor w_i consists of weighting and normalisation factors. For example, in the case of Equation 1 this means that $w_i = w_i^F / N_i(F)$.

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